

Draft Intensive study plan for the Delta Cross Channel

Introduction

The Delta Cross Channel (DCC) is an important facility for the protection of water quality and salmon migration success. Water quality in the south and central delta can be improved (under low flow conditions) by opening the channel. Unfortunately, fish migration success is improved by closing it. In 1999, these two conflicting needs led to violations of water quality standards and subsequent degradation of protection of Sacramento salmon outmigrants, particularly the endangered spring-run yearlings.

Examination of methods to improve operations of the DCC operations to protect salmon and water quality are explicitly called for in provisions of the CVPIA, the CALFED Record of Decision, and in implementation of the spring-run protection plan.

As part of a special meeting of the Bay-Delta Modeling Forum in February of 2000, hydrodynamic model results were presented which indicated that almost all of the water quality benefits associated with the DCC could be achieved by opening the gates only during the time when tidal stage in the Sacramento River was rising. The lag in timing between flood tides entering the central delta versus the Sacramento River produces a hydraulic gradient that forces water into the DCC only during this part of the tidal cycle. Because intrusion of salt water into the delta is greatest during the spring portion of the neap-spring tidal cycle, modeling results suggest that water quality could be protected by opening the gates during flood tides of the spring tidal cycle almost as much as keeping the gates open constantly. Thus, water quality could probably often be adequately protected by opening the gates only 25% of the time in every 2 week period.

It is unclear how much such tidal operations of the DCC would protect migrating salmon. From the available data, three alternative hypotheses regarding salmon sensitivity to DCC operations are reasonable:

1. Fish move with the movement of water. Thus, if gates are operated in such a fashion that they take as much water in 12 hours as they would in 24, the same number of fish will be diverted as if the gates were open constantly.
2. Fish move constantly downstream. Thus, if gates are closed 12 hours out of every 24, half as many fish will be diverted.
3. Fish move downstream during specific parts of the day so that the number diverted is a function of the time of tidal or solar day. There are two principal sub-hypotheses:
 - 3a. Fish primarily move downstream on ebb tides. Thus if gates are closed on the ebb and open only on the flood, fish will move past the diversion when it is closed and the number diverted will be very small.
 - 3b. Fish movement is controlled by photoperiod. Thus, if gates are closed during the time of day when fish are actively migrating, diversion of fish could be greatly reduced.

Analysis of existing datasets has failed to fully resolve fish movement patterns in the area of the DCC, although both tidal and diel patterns have been reported.

An additional concern centers around upmigrating adult salmon. Some of these fish originate in the Mokelumne River and their passage through the central delta is a necessary part of their migratory path. However, for Sacramento River stocks, there is considerable concern that movement of Sacramento River water through the DCC causes some fish to move off their most direct migration path and be slowed or blocked in their movement toward their natal streams.

Conceptual models:

Three conceptual models regarding fish and water quality intersect around the operation of the DCC.

Water quality (in terms of salinity and total dissolved solids) in the south delta is a balance among inflows in the major rivers, export pumping rates, tidal conditions, weather conditions, agricultural activities generating return flows and the operation of the Delta Cross Channel gates. When open, the Delta Cross Channel (DCC) gates allow Sacramento River water pass into the interior delta and keep the source water for delta export in a less saline condition than would otherwise occur. Passage of water through the channel is largely due to differences in tidal stage in the interior delta usually lagging behind the rise in stage in the Sacramento River. This difference in stage is greatest during the flooding tide in the mainstem and is minimized, or even reversed, during the ebb tides. Water quality in the south delta is therefore likely to be as well protected by tidal operations of the gates as by a constant open condition.

Juvenile outmigration through the delta is a sensitive life stage for Sacramento populations of chinook salmon. Data collected in the field have shown higher rates of survival for fish not exposed to interior delta conditions. Passage into the central delta from the mainstem occurs principally through the Delta cross channel and, so, closure of the gates is the most effective tool available to improve salmon outmigration survival rates. Temporal patterns of outmigration of young salmon past the DCC is not well understood, so complete closure of the gates is the safest method of improving survival. If passage downstream occurs in conjunction with ebb tides or with time of day it may be possible to achieve a high level of protection despite some gate openings to protect water quality.

Adult upmigrating salmon follow chemical traces of their natal stream waters on their spawning migration; deviations or delays in this migration are believed to decrease their reproductive success. Passage of Sacramento River water through the DCC may cause Sacramento stocks of salmon to enter the central delta and operation of the DCC gates may slow or prevent their successful passage to their natal streams.

Hypotheses:

#1. Opening the cross delta channel gates only during the flooding portion of the tidal cycle will achieve approximately the same water quality objectives as the fully open state.

#2. Distribution of adult and juvenile fish within the channel and near the DCC is a function of the distribution of their preferred velocities.

#3 The percentage of juveniles entering the DCC is a function of flows into the DCC when they are near it.

#4 Outmigrating juveniles move down more during the day than during the night

#5 Outmigrating juveniles move down more on ebb than flood tides.

#6 Tidal operation of the DCC will attract more adult salmon up the lower forks of the Mokelumne than when fully closed

#7. Tidal operations of the DCC will lead to quicker, more successful migration of adults from the central delta to the Sacramento River than the fully closed condition

Proposed studies.

The Delta Cross Channel Project Work Team (DCC PWT) was formed by the Interagency Ecological Program (IEP) to develop a plan of operations of the DCC for fall 2000 that would address the water quality and fishery concerns raised in the fall of 1999. The DCC PWT has attracted the involvement of a wide variety of interests and expertise. The team now proposes a series of studies and experiments that are expected to greatly reduce the uncertainties surrounding these issues and provide a solid basis both for DCC operations later this year and for the early stages of CALFED implementation.

The hypotheses described above are addressed by at least one of the studies described below. In several cases, the same hypothesis is addressed with different methods. All of the methods of sampling fish are subject to differences in gear effectiveness. We hope to find similar results from different simultaneous studies as a way of increasing confidence in our results. The hypotheses relevant to each study are identified by number. Some important expected results are not tied to specific hypotheses; particularly of interest will be the detailed qualitative profiles of hydrodynamics and movement of individual radio-tagged fish.

Part of this study is the incorporation of DWR's real-time modeling effort to guide operations. Each day field information will be used to generate a forecast of conditions for the next seven days. This should minimize the potential for unpleasant surprises and provide time to make a considered response to any problems that arise. In addition, DWR and USGS modeling have been fundamental in designing several of the proposed studies. At the completion of the field studies, particle tracking modeling will be used to mimic the behavior of neutrally buoyant particles to compare with observed behavior of fish.

Hydrodynamics

Rick Oltmann and Jon Burau of USGS and Chris Enright and Howard Mann of DWR have placed a series of ADCP velocity meters in the Sacramento River near the DCC, within the DCC,

and east of the DCC at two sites in the Mokelumne River. These meters will give a detailed description of the flow structure encountered by fish as they traverse the confluence of the Sacramento River and DCC, and will provide flow information in all the important channels of the DCC region. During the fish release studies, USGS and DWR will be making intensive studies of the flow patterns with boat-mounted UVM in the area around the DCC to provide an exact three-dimensional picture of the flow fields the fish encounter. In addition to basic hydrodynamic profiles these results are basic to hypotheses #1 and #2.

Water Quality

David Briggs of Contra Costa Water District has proposed a series of operational conditions for the DCC for nine weeks beginning one week after the Labor Day weekend. The EC meters presently in place at Chipps Island and Jersey Point will permit analysis of the degree of salinity intrusion by examining the change in the ratio of EC at the two sites.

The proposed DCC operations are:

open gates for three weeks from September 6 to September 27.

open gates at the end of every slack low tide in the Sacramento River and close them at the start of the slack high water for three weeks from September 28 to October 19.

Close gates for three weeks from October 19 to November 8 (this is the least necessary condition for the study and can be aborted if salinity rises to levels of concern).

Costs for this study are limited to the costs of personnel and gear required to operate the gates in a tidal fashion for three weeks. The Delta Mendota Water Authority is placing lights and other safety gear on site and has been training new personnel for nighttime operations. All relevant EC data are presently telemetered as part of the compliance monitoring network. This study is the principle test of hypothesis #1.

Salmon Smolt Studies

Mass tagging

Mark Pierce and Erwin Van Nieuwenhuysse of USFWS Jim White of CDFG, and Rick Sitts of Metropolitan Water District are developing two releases of marked fish upstream of the DCC. Midwater trawls will be performed in the Sacramento River downstream of the DCC and in channels east of the DCC to monitor the movement and timing of fish at this flow split. 120,000 smolts are available from the Coleman National Fish Hatchery. The fish will be spray-dyed with four colors to allow rapid identification upon recovery. The four colors will allow identification of fish released on ebb vs flood tides and right-bank vs left-bank releases. Releases of marked fish will occur on November 13th and 20th. Trawls to recover the released fish will proceed constantly for 48 hours following each release. This study will provide significant tests of hypotheses #4 and #5.

For this study (and the next) DCC gates would be open from November 9th through November 25th.

Radio tagging

Dave Vogel of Natural Resource Science Inc. (NRSI) has been performing radio tag tracking of fish in the delta under contracts from EBMUD and CVPIA. NRSI will study fish movement near the DCC in a brief and intensive study immediately following each tagging study. Radio tagged fish will be released near the release site of marked fish after the cessation of downstream sampling and will continue for two days between the release site to downstream of the DCC in the Mokelumne and Sacramento rivers (November 9th and 10th and again on November 16th and 17th). This study can directly test hypotheses #3, #4, and #5. The number of fish tagged will control the degree to which tests of hypothesis #3 are appropriate.

Hydroacoustic studies

Gordon Mueller (USGS) and Mike Horn (BOR) are working with Pat Brandes (USFWS) on a study of the movement of the spray-dyed fish from near their release point to below the DCC. For the two days of the dyed-fish study hydroacoustic surveys will be made at roughly 2 hour intervals in the mainstem Sacramento River from below the DCC to the release sites. With 30,000 fish in each release group, it is expected that the hydroacoustic gear will be able to estimate the dispersion, location, and movement of most of the released fish. Like the radio-tagging, this study can directly test hypotheses #3, #4, and #5.

Adult salmon

Radio tagging

Dan Odenweller of CDFG is leading a program that catches and radio-tags adult, upmigrating salmon at Jersey Point on the San Joaquin River, as part of an investigation into the migratory paths of adults salmon through the south delta. Some of the fish that he catches are probably of Sacramento or Mokelumne stocks. Four additional stationary transceivers to record the passage of radio-tagged fish are available for use this fall. Dan proposes placing these on the north and south forks of the Mokelumne as well as near the DCC and in the mainstem Mokelumne. These transceivers would allow identification of the routes and fates of adult salmon that might be drawn into the central delta by diversions through the DCC. This study addresses hypotheses #2, #6 and #7

Hydroacoustic studies

Gordon Mueller (USGS) and Mike Horn (BOR) are working with Pat Brandes (USFWS) to monitor movement of adult salmon in the vicinity of the DCC During the months of October and November. These studies will assess whether the DCC is a significant barrier to upstream migration by comparing densities in Georgiana Slough, the Mainstem Sacramento and in the DCC during times when the gates are tidally operated and when they are closed. This also study addresses hypotheses #2, #6 and #7

Fyke net studies

Hydroacoustic gear is unable to identify species of fish, although size and behavior can give many clues. Jeff MacLain of USFWS has developed a study to sample upmigrating adult salmon which should help to verify that the fish studies by hydroacoustics are actually salmon. The

study will address the same questions of the importance of each migratory pathway for adult salmon under different operational conditions of the DCC in the months of October and November. This study also addresses hypotheses #2, #6 and #7

Expected products

At a minimum this effort will produce:

1. Recommendations will be made to DAT, OFF and the Ops Group for operations of the DCC gates from November 22 to January 31 in a fashion that optimizes salmon protection while preserving water quality in the central and south delta.
2. Report of findings that will serve as the basis for CALFED studies of the DCC and the proposed Hood-Mokelumne connector.
3. Article summarizing results for a general audience in the winter or spring 2001 IEP Newsletter.
4. Oral presentations of significant results at the 2001 IEP Conference at Asilomar.

In addition, it is the intent of the IEP PWT to produce articles in the peer-reviewed scientific literature as results warrant.